International Journal of Applied
and Natural Sciences (IJANS)
ISSN(P): 2319-4014; ISSN(E): 2319-4022
Vol. 3, Issue 1, Jan 2014, 19-24

International Academy of Science,
Engineering and Technology
Connecting Researchers; Nurturing Innovations

EXPERIMENTAL ANALYSIS OF A SINGLE SLOPE SINGLE BASIN SOLAR STILL WITH HOT WATER PROVISION

S. SHANMUGAN

Research Center of Physics, Dhanalakshmi College of Engineering, Chennai, Tamil Nadu, India

ABSTRACT

In this paper present has been worked in design, fabricate and experimental analysis of single slope single basin solar still. These models have been developed based on purified water and hot water. The experimental analysis of a single slope single basin solar still is affected by design and parameters like water temperature, basin liner temperature, hot water temperature, glass cover temperature, ambient temperature and solar intensity. The experimental analysis of the system has been measured 24 hours output values 4.915 kg/m^2 and hot water 45.500 kg/m^2. The facile approaches analysis has been carried out for natural circulation of water temperature sunny hour's (11.00am to 3.00pm) continuous output temperature 53°C, respectively. The experimental calculations have been made for one of the typical days under in Chennai at Manimangalam climatic condition.

KEYWORDS: Basin Solar Still, Solar Hot Water, Thermal Model Efficiency, Productivity

INTRODUCTION

Researchers have reviewed the performance of inverted absorber solar still [1] Rahall Dea *et al*. and found that thermal efficiency of inverted absorber solar still is thrice than that of the normal solar still. [2] Tiwari *et al.*, have studied the comparative performance of an active solar distillation system integrated with FPC, concentrating collector, evacuated tube collector with and without heat pipe and tried to evaluate the theoretical yield. It has been concluded that the still integrated with evacuated tube collectors had shown better results than the other collectors.

[3] Khalifa and Abdul Jabber have found the effect of condensing cover tilt angle of simple solar still on the productivity in different seasons and latitudes. It has been found that the tilt angle should be large in winter and small in summer.

[4] Kalidasa Murugavel and Srithar have conducted experiments for the still up to a minimum depth of water and different wick materials like light cotton cloth, sponge sheet, coir mate and waste cotton pieces, and aluminum rectangular fin arranged in different configurations in the basin. [5] Rahim *et al.* have an approach in a conventional still to store excess energy during daytime that could be used to continue evaporation at night. In this work, the authors divided the basin water into evaporating and heat storing zone. They found that the heat storage capacity of the water during daytime was about 35%of the total amount of solar energy entering the still.

Design of the System

The photograph of the experimental single slope single basin solar still is shown in the Figure 1a, 1b and 1c. The still consists of outer and inner enclosure made of plywood with dimension of 1.3 x 1.3 m and 1.25 x 1.25m. The gap between the enclosures is filled with glass wool having the thermal conductivity of 0.0038 W/mK. The height of the back wall is 0.03m and front wall of 0.10m. The glass cover of

Figure 1a: Photograph of the Experimental Still

Figure 1b: Photograph of the Coil Fixed in the Basin

Figure 1c: Photograph of the Coil and Drip Fixed in the Basin

Thickness 4 mm is used as the condensing surface and the slope of the glass cover are fixed as 11º which is equal to the latitude of the location (Chennai). The still is made vapor tight with the help of metal putty. The j-shaped drainage channel is fixed near the front wall to collect the distillate yield and the output trickled down to the measuring jar. The basin of the still is made of copper sheet in the basin and painted black to absorb more solar radiation. A special arrangement has been made to pour saline water drop by drop in the basin to maintain least water depth. The arrangement is made of heat resistant pipes with drip button fixed at regular intervals of 0.10m horizontally in the basin. The single slope single basin solar still was consisting of a copper sheet used for fabricating the still with a water depth of 0.002m. The basin inner side fixed a copper coil and serpentine heat exchanger made of copper with length 5.0m and diameter of 0.01m was welded to the upper surface of the still absorber plate. The gold water inlet fixed water flow meter an insulated tank was used as a fluid flowing through the heat exchanger to extract the heat from the saline water inside the

basin area of the still under the open cycle continuous flow heating mode in 11.00am to 3.00pm. An insulation water tank was fixed at a relatively high place to achieve the required pressure difference needed for water flowing. The hot water outlet was connected to the storage tank via an insulation pipe to minimize heat loss. The basin temperature, saline water temperature, condensing cover temperature of the still and inlet, outlet hot water temperature of the system has been measured by fixing copper-constantan thermocouples which has been calibrated initially. Solar radiation intensity and ambient temperature have been measured with solar radiation monitor and digital thermometer.

Experiment has been carried out from 6 am to 6 am of 24h duration with compare ordinary basin type still and drip button use basin still for during summer days at Department of Physics, Dhanalakshmi college Engineering, Chennai – 601 301 [latitude 13º 04'N, long 80º 17'E], Tamilnadu, India.

Experimental Analysis of a Single Slope Single Basin Solar Still

The following assumptions have been made to write the energy absorb in the system.

- There is no temperature gradient throughout the condensing glass cover surface.
- The system is made vapor tight such that there is no vapor leakage from the still.
- The condensing glass cover and water surface are parallel due to small inclination of the glass cover.
- The hot water is natural circulation mode to the still during sunshine hours in the basin.
- The governing heat transfer coefficients in the still are temperature dependent.

RESULTS AND DISCUSSIONS

Experiments have been carried out with the single slope single basin solar still for number of days during January 2013 to June 2013. Observations for one of the four typical days in the month of February to May have been used to predict the performance of the system. Hourly variation of solar radiation and ambient temperature for four experimental days has been depicted in Figure 2. It is observed that the hourly variation of solar radiation and ambient temperature have same trend. Solar radiation intensity and ambient temperature is found to be maximum at noon and then decreases gradually till 5pm.

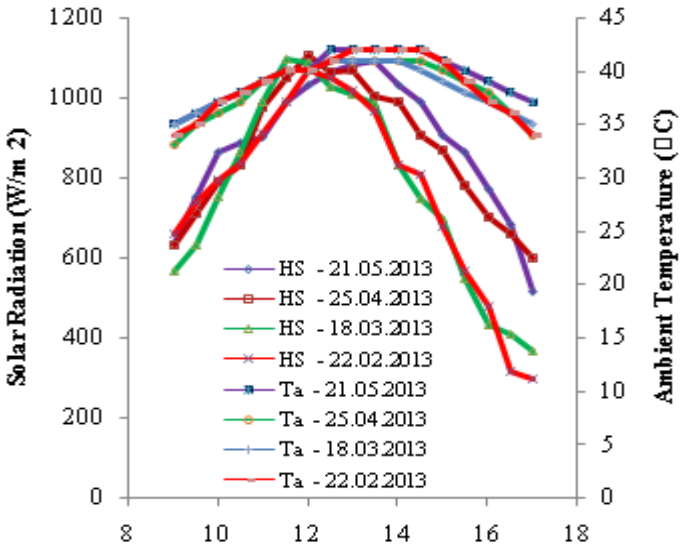

Figure 2: Hourly Variations of Solar Radiation and Ambient Temperature in Different Days

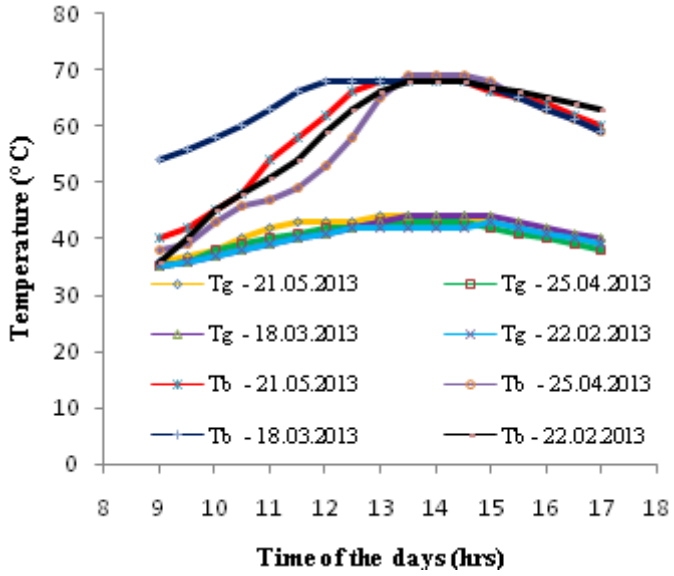

Figure 3: Hourly Variations of Experimental Values of Basin and Glass Cover Temperature in Different Days

The analytical expressions derived for the basin and glass cover temperature have been used to evaluate the instantaneous temperature of the same with the measured climatic and design parameters of the still. The calculated values have been compared with the experimental observations to predict the validity of the thermal model. Figure 3 have shown the measured and calculated value of temperature of the basin and glass cover temperature with different days.

The figure 4, Hourly variation of production rate, water and hot water temperature have been taken by dripping saline water with dripping arrangement to maintain least water depth. Experiment dripping has been carried out with 1.5cm of saline water along the basin. The system has been taken by experimental maximum water temperature 67°C and hot water temperature 53°C.

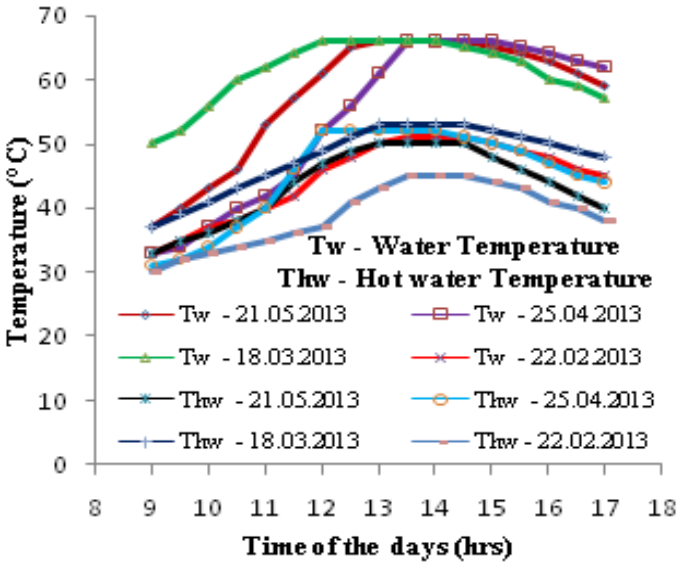

Figure 4: Hourly Variations of Experimental Values of Water and Hot Water Temperature in Different Days

The instantaneous distillate yield and hot water in the basin have been shown in the figure 5. The temperature difference between the water and hot water temperature with dripping is small due to large thermal capacity and the rate of evaporation is moderate. The maximum still is distillate yield of 0.350 [kg/m^2] and hot water output 3.455 [kg/m2] 30 minutes is obtained between 1.30 pm and 2 pm which is expected. The still is provides a total distillate yield

of 4.915 [kg/m^2] and hot water 45.500 [kg/m^2] from 9 am to 5 pm. Moreover the overall distillate output in 24 hr cycle for the system with by dripping is found to be 5.630 kg/m^2.

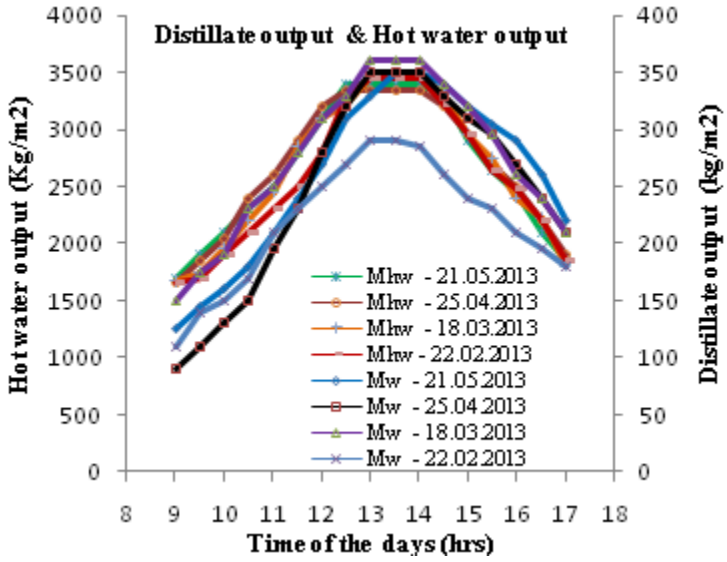

Figure 5: Hourly Variations of Experimental Values of Distillate Output and Hot Water

CONCLUSIONS

The following conclusions have been drawn and are

- In the case of saline water in the basin, the total production decreases due to large thermal capacity. Dripping of saline water increases the temperature difference between the condensing glass cover and water temperature in the basin due to low thermal capacity.
- Optimization of the design parameters is possible with the thermal model proposed and can be used for large scale installations
- The overall output of the still is found to be 4.915 [kg/m^2] and continuous output temperature 53°C, the estimated production rate is in close agreement with the experimental values.

ACKNOWLEDGEMENTS

I express my sense of gratitude to **Dr. B. Janarthanan**, Asst. Professor Dept of Physics, Karpagam University, Coimbatore, who helped me to explore in this field. I express my sincere thanks to **Dr. V. R. Ramamurthy,** Chancellor, Dhanalakshmi College of Engineering and Chairman and Managing Trustee, for providing financial help to complete this project work successfully.

REFERENCES

1. Rahall Dea, Sabah A, Abdul-wahab and Tiwari GN, Performance study of the inverted absorber solar still with water depth and total dissolved solid. Applied energy 2011; 88: 252-264.
2. Tiwari GN, Vimal Dimri, Usha singh, Arvind Chel, Bikash Sarkar, Comparative thermal performance evaluation of an active solar distillation system. International Journal of Engineering Research 2007; 31:1465-1482.
3. Khalifa Abdul Jabber N, On the effect of cover tilt angle of the simple solar still on its productivity in different seasons and latitudes. Energy Conversion and Management 2011; 52:431-436.

4. Kalidasa Murugavel K, Sridhar K, Performance study on basin type double slope solar still with different wick materials and minimum mass of water. Renewable Energy 2011; 36: 612-620.

5. Rahim NHA, New method to store heat energy in horizontal solar desalination still. Journal of Renewable of Energy 2003; 28: 419-433.